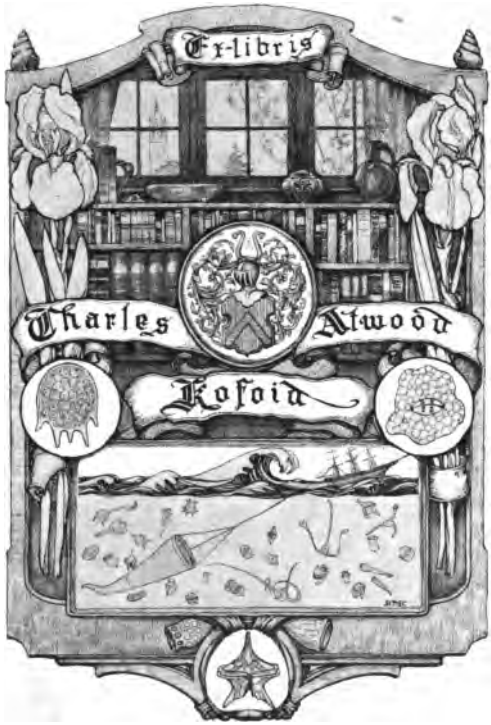
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ON THE EVOLUTION OF WOUND-TREATMENT DURING THE LAST FORTY YEARS

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ON THE EVOLUTION OF

WOUND-TREATMENT

DURING THE LAST FORTY YEARS

Being the Dr. James Watson Lectures delivered at the Faculty of Physicians and Surgeons of Glasgow in February, 1906

By

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LECTURE I.

When the President and Council of the Faculty did me the honour of inviting me to deliver the present lectures,[1] my first and greatest difficulty was to select, if possible, from the wide range of subjects at my command, one which might prove of interest to the greater number of my audience, rather than one which must of necessity appeal to comparatively fewer—in other words, it seemed well to select a subject dealing with some surgical principle or system, rather than one so limited in its interest as would be the consideration of a special disease or group of diseases. Another reason for the choice which I have made presented itself in the fact that the principles which underlie all modern wound-treatment were first recognised and put into practice by the then Professor of Surgery in our Uni-

[1] Since these lectures were delivered they have been revised by Lord Lister, and he has, with much kindness, re-written some passages in the second lecture. These emendations I have accepted very gratefully, since they give to the views set forth the value of his authority and approval.

versity, while one of the earliest and most important communications regarding them was made by him to a very large audience in the room in which we are now met. But most of all, perhaps, have I been influenced by the belief that, in the minds of many at the present day, especially among the younger surgeons, there exists an erroneous view as to the aims which Lister had even in his earliest efforts to avoid suppuration, and as to the methods which he advocated from time to time for that purpose. If one may judge from much that one reads and hears, many have been led to believe that those aims and methods were, in important and essential respects, distinctively other than those which now regulate the more advanced forms of surgical practice, and that, while he must be fully acknowledged to be the author of our modern surgery, its practice now is a great and beneficent advance on anything which he taught. How far such a mental attitude is justified or not is a matter which may be best determined by observing and tracing the evolution of wound-treatment in the light of its history during the last forty years.

The growth of human power in any department of human activity has never been continuous, uniform and uninterrupted. Rather it has proceeded as time has slowly rolled on its way by

startling and unforeseen occasional bursts of progress, separated from one another by periods which, although enriched by inherited acquisitions, have themselves shown only an even and unexciting pace of advancement.

> "Ages elapsed ere Homer's lamp appeared,
> And ages ere the Mantuan swan was heard;
> To carry Nature lengths unknown before,
> To give a Milton birth asked ages more."

And what is so true of Literature is not untrue, in many respects, of Science, and of those applications of Science, upon which the prosperity and the power of mankind so entirely depend. In this way we recognise that genius "rises and sets" only "at ordered times," and we have crystallized the thought into that much abused but useful word—epoch-making.

If I ask myself what epochs in this sense have been inaugurated in the past history of our own art of surgery, on what occasions and by whom have ideas and principles been announced and carried into effect which have quickened progress over the whole domain of the art, and increased its power for the future as compared with the past, I can only think of three occasions of such paramount importance. One was when Ambroise Paré substituted the use of the ligature for the red-hot knife and cautery; a second when Morton

demonstrated that human beings could be operated upon painlessly under the influence of anæsthetics; and the third and last when Lister, founding upon the researches of Pasteur, introduced the antiseptic principle in wound-treatment.

In the forty years which have since elapsed, to use a frequently repeated expression, the practice of surgery has been revolutionized, and a progress made such as past centuries had not achieved. Lucas-Championnière was not, therefore, unjustified when he said that there are only two periods in surgery—that before Lister, and that since Lister, and it is to the gradual evolution of the latter period that I desire now to direct your attention. I have already, in the Lister Jubilee Number of the *British Medical Journal* (13th December, 1902), gone over a considerable portion of the same ground, and I must, in order to be consecutive in my remarks, once more travel over it. I can hardly fail in doing so to repeat myself, since in walking more than once between two given points, one is always apt unconsciously to tread to-day in the footsteps of yesterday. I trust that any of you who have done me the honour of reading the paper I have referred to, may not feel the repetition too tiresome.

In the period immediately preceding the introduction of the antiseptic system of treatment,

wounds were probably best and most safely treated in accordance with the simple plan practised and taught by Mr. Syme in the Edinburgh School. He, and probably many others, had long before recognised the fact that union depends upon a peculiar living power and action in the wounded tissues, and in no way upon the virtues of any superstitious observances or even upon those of balsams, lotions, and other local applications. Not only was there no longer any need for using "mundifying," "incarning," and "cicatrizing" applications in due succession, but the numerous and much vaunted liniments and ointments which had succeeded that ancient form of practice were equally unnecessary. Writing in 1867 (*Lancet*, 6th July), that is, after the first papers on the antiseptic system of treatment had been published, Syme referred to an early paper of his own as follows:—"In the *Edinburgh Medical Journal* of 1825 there is a paper on the Treatment of Incised Wounds, which I wrote in order to show that the retention of blood between the cut surfaces was a great obstacle to their adhesion, and to suggest the treatment that seemed best calculated to prevent this effect. In those days it was the custom to seal up wounds immediately after their infliction by straps of adhesive plaster, which prevented the discharge of any fluid

from the cavity, so that when the edges united, as they frequently did, a troublesome abscess was sure to result. Unless, therefore, the solution of continuity had two orifices, as when seated in the lips or cheeks, so that there was thus afforded a drain for the bloody or serous effusion, complete primary union was hardly possible. The means that seemed most suitable for counteracting a want of drainage, on the other and more ordinary occasions when there was only one orifice, was to delay the closure of the wound until the oozing from it appeared to have ceased, to apply pressure along the course of its sides, and to place some bibulous material over the lips." His later practice in accordance with these views was as follows:—He arrested hæmorrhage in the case of small vessels by means of torsion, as suggested by Amussat, but was deterred from doing so in that of the larger vessels to some extent at all events, from the fear, as he himself tells us, "that the absence of ligatures which serve as the conductors of the discharge, would increase the risk of blood or serum being pent up in the cavity." The ends of the long, well-waxed silk ligatures, tied as they were upon vessels fairly equally distributed throughout the wound, were left hanging out at its angles, and were relied upon and valued, not merely as hæmostatic, but as

draining agents. The stitches were of silver wire, as recommended by Marion Sims in 1857. Pressure was made on the flaps or sides of the wound by folded pads of dry lint, and a piece of the same material was bandaged lightly over its lips. When a complaint of pain and a quickened pulse gave the warning of commencing suppuration (for only in the smallest and simplest wounds was union by first intention ever seen), these dressings were removed by being bathed with warm water, and either a water dressing covered with guttapercha tissue or a poultice, was applied. Frequent change of the dressing and washing of the wound with Condy's Fluid and water was practised as long as necessary. Complete union could not be looked for, under any circumstances, until the last of the ligatures had separated, which might be three weeks, or even longer, after the infliction of the wound. When I first became a dresser, the carrying out of all such details was my daily occupation. Every wound discharged pus freely, and putrefactive changes occurred in the discharges of all, producing in the atmosphere of every surgical ward, no matter how well ventilated, a fœtid, sickening odour, which tried the student on his first introduction to surgical work just as much as the unaccustomed sights of the operating theatre. It

is hardly necessary to add that fatal wound diseases and complications were never absent at any time from the hospitals of that day.

While many surgeons, in accordance with such teaching as I have referred to, regarded the retention of the wound products as the most potent cause of suppuration, and were disposed, while using as few ligatures as possible, to value those they did use for their power of drainage, there were others who attributed to the ligatures all the mishaps and difficulties incidental to wound-healing. The man who most insisted upon this view of the case was Sir James Y. Simpson. Viewing the silk ligatures as unmixed evils, as little better than so many putrid setons so long as they remained in the wound, he devised what he considered an altogether more desirable hæmostatic agent, viz., acupressure. By means of metallic needles introduced in various ways he compressed the divided arteries. This method of treatment, although devised in Edinburgh, and put to the test in many parts of the country, was really most practised in the Royal Infirmary of Aberdeen. Professor Pirrie and the other surgeons of that Institution undoubtedly made some very remarkable progress, in so far as they were able to publish many cases of large wounds, such as those of amputation of the limbs and excision

of the female breast, which had healed without any suppuration whatever. At the very same time Lister had begun the antiseptic system of treatment in Glasgow, and was also claiming to be able to prevent suppuration in wounds. The two forms of treatment started almost simultaneously on a race for public favour, and the spirit of rivalry was inevitable. It is not hard now for us to see that one of those methods was doomed to ultimate neglect. The replacement of the absorbent textile ligature by a metallic needle no doubt removed one obstacle to the exercise of that protective power which our living bodies possess, and by which they can sometimes defend themselves successfully against the malign effects of organic germs which may have been introduced from without, provided these do not enter too abundantly or in too virulent a form. In a certain number of cases, therefore, of incised wounds even of large size, immediate union was safely accomplished. But the gradual growth of antiseptic surgery, and the knowledge of wound infection which grew with it, long ago convinced everyone how comparatively seldom such fortunate results could be looked for.

Hitherto medicaments used in wound-treatment had been always applied more or less empirically, and it was hard, perhaps, to appreciate the fact

that carbolic acid was not used by Lister (as it undoubtedly had been previously used by others) as "a local dressing of wounds" with the view of acting directly, and with a specific healing influence, on the wounded tissues, but rather that it was employed to destroy germs which, if they reached the wound in the living state, had the power of preventing the natural processes of repair. While others had attempted by the use of carbolic acid to lessen the discharge and fetor of suppurating surfaces, Lister taught that its beneficial influence, as he employed it, was entirely due to its germicidal action and its consequent power against the sources of disturbance, which existed in the dust of the surrounding air and on such surfaces and objects as had come into contact with the air. He had long taught that wound inflammation and its consequences were due to the chemical changes which occurred in the putrefaction of blood and serum, but only began to realise the character of the interaction of wounds with outside agencies after Pasteur published his researches on fermentation in the early sixties. No sooner had he read the papers of Pasteur in the *Comptes Rendus* than he seems at once to have felt that the views there given of the cause of the decomposition of organic fluids which had been in contact with the air, satisfactorily explained

much that had hitherto been mysterious in the behaviour of wounds, and might show the way towards the prevention of much that was fraught with danger, and hitherto unpreventable.

Although only forty years have elapsed since the time of which I speak, it is very difficult for the younger members of the profession now to realise the great scepticism and contemptuous criticism with which such a doctrine was received. Sir James Simpson was by no means the only one who regarded the atmospheric germs as "mythical fungi"; and many spoke of such teaching as if it were rather a revival of beliefs like those regarding the ærial sylphs and spirits of Rosicrucian philosophers, than a sane scientific discovery. Now, when we recognise those early researches and experiments of Pasteur to have been the foundation upon which a wonderful and fruitful Science has been reared; now that laboratories have been built for its prosecution and professorships founded for its teaching, we marvel rather that they should not have been at once accepted with enthusiasm and full belief. It is only another proof of the often-recognised fact that new ideas seldom greatly influence the generation in which they have their source. They gain the assent then of only a minority, and are disregarded by the majority which adopts them later.

It has been more than once supposed and stated that Lister had made some forms of bacteriological investigation before he became aware of the work of Pasteur, but this was certainly not the case, as he himself has always indicated. Professor Annandale, in his communication to the Lister Jubilee Number of the *British Medical Journal* (December, 1902) as to Lister's early work in Edinburgh, fell into this error when he wrote:— "Before leaving for Glasgow in 1860, Mr. Lister had commenced his bacteriological work in connection with antiseptics, but at this time the practical details were still in their infancy, and it was not until after much further experience that antiseptic surgery became simplified and satisfactory as regards its practical application." His old Glasgow colleague, Sir William Gairdner, also fell into the same mistake. He wrote me, after the articles in the *British Medical Journal* to which I have already referred had been published, giving expression to his belief that Lister and he had held a conversation in Edinburgh before either of them came to Glasgow, regarding a case of hydro-pneumothorax, in which Sir William was interested, and that this conversation showed that Lister then entertained distinct views as to putrefaction being caused by atmospheric germs. After I had assured him, on Lord Lister's authority,

that this was not so, he replied in a letter which in many ways is so interesting, that I offer no excuse for reading it to you. "I suppose after all then," he wrote under date 24th January, 1903, "I must have got mixed in my dates somehow as to Lord Lister's communications with me *re* pleural effusions. It may have been that he told me of the case referred to in your note of 4th instant, and that I may have remarked to him how curious it was that pleural effusions, associated with pneumothorax, are so rarely putrefactive. Of course, when the ingenious experiments of a later date, following up Pasteur's ideas, came to my knowledge, they would come quite pat to the subject; and I had it in my mind accordingly that the germ of these had existed in Lister's mind before he left Edinburgh. But this only shows how easily one is led astray when dealing with nascent ideas or advances in thought of any kind. The whole incident serves, perhaps, to cast a little light on the confusions which sometimes arise in self-assertive minds on the question of priority. Lister's is, happily, *not* such a mind; quite the contrary. But, if the almost *unthinkable* case should have arisen of his having wanted to show that he had himself partially anticipated Pasteur, and he had applied to me, I should have been very much inclined to say that he had, in

so far at least as to have revealed some trace of a germ theory of putrefaction before he left Edinburgh. Of course it did not present itself to me quite in this way, because I did not know till you told me the date of Pasteur's first researches."

It is well, then, that the fact should be clearly understood that Lister's treatment was founded on Pasteur's demonstrations and writings. No man ever acknowledged an indebtedness more often and more unequivocally than he has himself done in this matter. In the very first communication he made to the profession of the new method of treatment (*Lancet*, 16th March, 1867) in connection with compound fracture, he dealt with this question of how the atmosphere produces decomposition of organic substances. He wrote: —"We find that a flood of light has been thrown upon this most important subject by the philosophic writings of M. Pasteur, who has demonstrated, by thoroughly convincing evidence, that it is not to its oxygen, or to any of its gaseous constituents, that the air owes this property, but to minute particles suspended in it, which are the germs of various low forms of life long since revealed by the microscope, and regarded as merely accidental concomitants of putrescence; but now shown by Pasteur to be its essential

cause, resolving the complex organic compounds into substances of simpler chemical constitution, just as the yeast plant converts sugar into alcohol and carbonic acid."

From this time, and for a great many years to come, Lister, knowing from Pasteur's researches that the germs contained in the atmospheric dust occasioned the decomposition of putrescible substances outside the body, assumed that they would have the same effect in wounds, and hence attributed to the atmosphere an importance in surgery which his own researches and experience showed him in after years that it did not possess.

In his earliest efforts at antiseptic treatment he directed his attention to compound fracture. That this form of injury should have been the starting point of such an attempt in treatment may be easily understood when one reflects how great was the contrast in those days between the course followed respectively by simple and compound fractures. The latter were the most fatal of all surgical injuries, and accounted for by far the greater number of the cases of pyæmia which were of such frequent occurrence in all hospitals. The first method adopted with a view to applying this newly conceived principle of treatment was as follows.

A small piece of calico, or lint, thoroughly

saturated with undiluted carbolic acid, and held in a pair of dressing forceps, was introduced into the wound, and all its accessible interstices were thoroughly and freely swabbed. Two layers of lint, also saturated with the undiluted acid, were laid over the wound, overlapping it in all directions for about half an inch. This was covered by a piece of thin block tin or sheet lead, moulded in a concave form so as to fit over the little mass of lint. It was fixed in position by strips of adhesive plaster, the limb being placed in suitable splints padded with some soft and absorbent material, which received such bloody discharge as oozed from the wound during the first day or two. The carbolic acid and blood formed a thick paste, with which the small mass of lint was thoroughly saturated, making it into a sort of crust or scab, which adhered to the wound with great tenacity. Once a day the tin cap was removed, and the crust of lint and blood was painted over lightly on its outer surface with carbolic acid. What was aimed at was to keep this crust from becoming septic, while the surface of it in contact with the wound became gradually free from the carbolic acid which it at first contained, and so, being unirritating in itself, permitted of healing beneath it. In this respect the early treatment was an imitation of

those few but fortunate cases, often referred to in the surgical writings of that day, in which a small wound communicating with a fracture became covered with a dry clot of blood or a dry piece of bloody lint. This adhered, and under it healing took place without suppuration. I do not, however, remember that union was completed under such artificial antiseptic scabs as I have described. The vapour of the often-renewed carbolic acid retained under the cap of tin interfered with the process of cicatrization, and, therefore, after it seemed likely that the wound was so far repaired as no longer to communicate with the seat of fracture, the antiseptic crust was detached, and the final closure of the surface wound allowed to take place under some simple form of dressing. By such treatment, crude and simple as it may now appear to us, it was abundantly demonstrated that suppuration might be prevented in compound fractures, and as safe and tranquil a course pursued as if the injury had been a simple one from the first. In those early experiments, as has been stated, carbolic acid was introduced into the wound in its full strength. The carbolic acid obtainable was very impure, and was quite insoluble in water. The first which Lister made use of, obtained from his colleague in the Chair of Chemistry, Professor Thomas

organisms in the air, one might expect that these might have been all filtered out in the wound, and left within easy reach of the carbolic acid applied. The patient recovered without the occurrence of suppuration, although he suffered from a subacute attack of traumatic delirium.

It was during this early period that Lister made those observations on the absorption of blood clot, dead bone, and sloughs of the soft parts, which gave rise to so much criticism at the time of their publication, and which suggested to him the very valuable practice subsequently introduced when he employed for the first time antiseptic absorbable ligatures. The grumous mass formed by blood and carbolic acid which filled the wound, was found capable of being converted into living tissue, in this sense, that as it was removed by absorption, new tissue formed *pari passu* by the organizing processes going on in the wound, and ultimately a living mass replaced the inanimate clot. In the course of the report of one of those early observations he wrote:—"I was detaching a portion of the adherent crust from the surface of the vascular structure, into which the extravasated blood beneath had been converted by the process of organization, when I exposed a little spherical cavity, about as big as a pea, containing brown serum, forming a sort of pocket in the

living tissues, which, when scraped with a knife, bled even at the very margin of the cavity. This appearance showed that the deeper portions of the crust itself had been converted into living tissue. For cavities formed during the process of aggregation, like those with clear liquid contents in a Gruyère cheese, occur in the grumous mass which results from the action of carbolic acid upon blood; and that which I had exposed had evidently been one of them, though its walls were now alive and vascular. Thus the blood which had been acted upon by carbolic acid, though greatly altered in physical characters, and doubtless chemically also, had not been rendered unsuitable for serving as pabulum for the growing elements of new tissue in the vicinity" (*Lancet*, 16th March, 1867).

In like manner he reported an observation, quite novel at the time, of the absorption of some dead bone on the end of a fragment which lay exposed in the wound of a compound fracture.

Shortly after this early work in relation to compound fracture, his attention was turned to the treatment of abscess, especially to that of large chronic abscesses associated with osseous caries—abscesses which we now know to be really the result of the tubercular process in bone. They were forms of disease which even in children were very fatal, and in the adult almost always so. A

case of abscess, in a middle-aged woman, pointing in one loin, having presented itself, and being on the point of bursting, an attempt was made to treat it in a manner resembling that which had been adopted in compound fracture. After the abscess was opened, some of its thick contents were mixed with liquid carbolic acid, and laid over and around the wound in two pieces of lint covered with a cap of block tin. When this dressing was changed next day, instead of pus escaping, as had always been the case under ordinary treatment, a drop or two of serous fluid exuded upon pressure. No material was now furnished with which to make a second dressing of the same character, and so in place of it a putty, made by mixing ordinary whiting (carbonate of lime) with a solution of carbolic acid in boiled linseed oil (1 to 4), was spread upon a piece of block tin, and laid over the incision, care being taken that this overlapped widely in all directions. It was fixed in position by straps of adhesive plaster, and over all an absorbent compress was bandaged. This case of abscess remained free from any septic change throughout, and ultimately healed, having furnished nothing from first to last but a steadily diminishing quantity of clear serous fluid. This was the first demonstration—and in those days it was necessarily an astonishing one—

of facts which became well established as the treatment was more and more developed, viz., that after the original contents of an abscess, whether acute or chronic, are evacuated, if changes in its interior, resulting from contact with outside morbid agents, be avoided, instead of pus, only a thin serous fluid will be discharged, and will rapidly diminish in quantity; that in consequence, it is a matter of indifference whether the opening made be dependent or otherwise, while the necessity for counter-openings no longer exists; that we may rely, under such circumstances, on the absence of all constitutional disturbance; and lastly, that such abscesses, if a careful course of antiseptic treatment be persevered in, may be expected to close satisfactorily and permanently.

The mode of treatment respectively of compound fracture and abscess was now, shortly stated, as follows:—In compound fracture, after the interior of the wound had been thoroughly washed out with a five per cent. solution of the acid, a piece of lint saturated with carbolic oil (1 to 4) was placed over it, and was large enough to overlap it a little in every direction, while over this was put a large dressing of the putty, smoothly spread on calico to the thickness of about a quarter of an inch, and covered with block tin. The dressing of putty was changed daily, but the

piece of oiled lint, soon saturated with blood, was left next the wound, harbouring under it a crust of blood of greater or less amount. It became usually fairly dry, and when the time arrived for discontinuing the splints, either a firm cicatrix or a superficial granulating sore was exposed to view. In opening an abscess, a large piece of lint, soaked in a solution of carbolic acid and oil (1 to 4) was placed over the portion of the skin to be incised, and left for a little to act upon it. The lower edge of it was then raised, the incision made, and the curtain of lint was let fall, the abscess being evacuated by gentle pressure under its protection. A narrow strip of lint dipped in the same oily solution was introduced through the incision, with the object alike of preventing primary union and of acting as a drain. On removal of the oily antiseptic curtain, a dressing of the putty, spread upon a piece of block tin, was immediately fixed over the incision by adhesive plaster, and bandaged to the part. The thin discharge flowed out beneath its edges, and it was renewed once a day. It is to be specially remarked that the antiseptic was never injected into the cavity of the abscess; experience having shown that to do so would be quite superfluous, while it could only do mischief by causing irritation. The covering of block tin was

afterwards dispensed with, the putty being spread upon calico; and thus modified, the dressing with putty was extended to the treatment of incised wounds made by the surgeon. But, in order to make it a success, it was evident that the old method of using the ligature must be either abandoned or modified. The observations already made on the absorption of portions of dead tissue in a wound treated antiseptically, led Lister to the practice of using buried ligatures, specially prepared with a view to their absorption. It seemed reasonable to hope that, just as dead bits of tissue had been disposed of by absorption, so more or less slender threads of organic material, prepared so as to be free of septic organisms, might be similarly removed.

Before putting the matter to the test in actual practice, he tied the left carotid artery of a horse (12th December, 1867) in the old Veterinary College in this city, with a piece of purse silk steeped in a strong watery solution of carbolic acid, the ends being cut short, and the wound dressed antiseptically. Healing occurred immediately. Six weeks afterwards, the horse having died, the parts were examined, and the results may be best stated in his own words. "On laying open the vessel, I found at the cardiac side of the ligature a firm adherent clot, an inch and a

it, pieces of its fibres being present in the puriform fluid, not having lost their elasticity, and not having been materially softened, but only "superficially nibbled, so to speak." "Indeed," Lister wrote, "considering the organic character of silk, the remarkable thing seems to be, not that it should be absorbed by the living tissues, but that it should resist their influence so long." (*Ibid.*)

The use of animal ligatures was next resorted to. Although ligatures of catgut, leather and tendon had long before been tried and abandoned, it was hoped that very different results might be obtained from their use in the absence of sepsis. There seemed no objection to using carbolic acid in the purification of the animal ligatures, for he had, as we have seen, already observed not only that portions of dead tissue and of blood clot, free from sepsis, were absorbed, but also that this process was in no way interfered with, when carbolic acid had freely acted upon them. He also had long been satisfied that the injection of a strong solution of perchloride of iron or tannic acid for the cure of nævi produces sloughs and clots which, though impregnated with those chemical substances, disappear without suppuration. On 31st December, 1868, he tied the right carotid of a calf at about the middle of the neck with ligatures of two kinds, separated from each

other by a distance of about an inch and a half. One was composed of three strips of peritoneum from the small intestine of an ox, twisted into a cord, the other being of fine catgut. Both had previously been soaked for four hours in a saturated watery solution of carbolic acid. The wound healed by first intention, and the calf was killed a month afterwards. He found on dissection, and at first, to his great disappointment, that the ligatures were still to all appearance present, and as large as ever; but more careful inspection showed that in reality they had been absorbed and "replaced by bands of living tissue, the growing elements of which had replaced the material absorbed, so as to constitute a living solid of the same form." Further, "they had indeed a deceptive resemblance to their former condition from the persistence in their substance of the impurities of the original materials, the darker adventitious particles being of mineral nature, incapable of absorption, so that they had remained as a sort of tattooing of the new structure." The fleshy bands so formed were found continuous with the arterial walls, and so far from weakening the vessel at the point of ligature, had rather strengthened and reinforced it, while, by the early healing of the wound, an immediate reconsolidation of the tissues detached

from the vessel had taken place. The evidence of the organization of these ligatures, though clear to the naked eye, was abundantly confirmed by the microscope. All these facts seemed to give sure promise, as indeed has proved to be the case, of security against the secondary hæmorrhage so frequent and so justly dreaded up to that time, as well as of the absence of suppuration in connection with such ligatures. Since then, the catgut ligature, prepared in one way or other, has been employed almost universally in tying arteries, whether in their continuity, or after being divided in wounds.

After the lapse of some time, it was felt that, although the antiseptic putty had yielded striking results, it was attended with various practical inconveniences, and Lister expended an enormous amount of time and patience in the attempt to find a satisfactory substitute. At length he discovered in shell-lac that which he was in search of. When carbolic acid was mixed with it, it formed a flexible material which retained the acid with great tenacity, and from this reliable reservoir the acid was given off constantly, but not too quickly. Spread as a plaster, it stuck, however, too firmly to the skin, obstructing all drainage. He had learned in other experiments that carbolic acid passed very freely through india rubber and

gutta percha, and this fact enabled him to get over this difficulty of the adhesiveness of the new plaster. A mixture of one part of carbolic acid in four parts of shell-lac was spread in thin layer on calico, and painted over with a solution of india rubber in benzine. When the benzine evaporated, the thin layer of india rubber was left, preventing all adhesion of the plaster to the skin, but in no way interfering with the action of the antiseptic. This dressing proved much more satisfactory in every way than the putty. It could not be disintegrated by friction like the putty, and being much lighter, was not only far less cumbrous, but could be more easily maintained in position, while, being always ready for use, it avoided the great inconvenience the putty had of requiring to be specially prepared by the surgeon. Hence, its use was resorted to alike in the treatment of injuries, abscesses and incised wounds.

No one has ever recognised more fully than Lister did the necessity of limiting, as far as was consistent with the avoidance of all fermentative changes in the wound, the irritating effects of the chemical substances employed in the treatment. His constant aim was to place wounds, as far as possible, in conditions resembling those of subcutaneous injuries, free from the access of external

morbid agencies, as well as from direct irritation by foreign substances. In order to avoid undue stimulation by the contact of the antiseptic dressings, he therefore endeavoured to devise something which, by its interposition between the dressings and the wound, would protect the latter without diminishing the efficiency of the former. He aimed at covering the wound itself with something more or less impenetrable to even the vapour of the carbolic acid, while the antiseptic dressing should overlap this widely in all directions. It had been proved that the acid passed easily through gutta percha tissue, and thin sheets of india rubber, but, on the other hand, the common oiled silk used for covering water dressings was much less penetrable by it. Taking this as a basis, he covered it with gum copal, which offers even stronger opposition to the passage of carbolic acid than oiled silk itself, and lastly painted over both a solution of dextrin. Before being applied to the surface of a wound this "protective plaster" was dipped in a solution of carbolic acid, the dextrin-coated exterior permitting of its being uniformly wetted. The acid was soon dissipated, and the plaster became an unstimulating covering of the wound, defending and protecting it from the direct action of the superimposed and widely-overlapping antiseptic

dressing, while in no way interfering with the outflow of the blood and serum.

One characteristic of these early methods, soon to be changed, was that the dressings were purposely made unabsorbent and impervious to the discharges. The putty and the lac plaster alike shed the fluids from the wound, and only acted upon them as they flowed beneath, preserving, by the volatility of the antiseptic they contained, an antiseptic atmosphere in the interval between themselves and the skin. They were reservoirs of carbolic acid, from which it was constantly given off, and out of which it could not possibly be washed, however great the flow, in the first instance, of blood and serum. It had become the practice in some quarters, to dress wounds with oakum, carefully selected and teased, and good reports were given of its virtues as an antiseptic dressing. It was the use of this substance which suggested to Lister the employment of gauze in surgical practice—a form of dressing which would absorb the fluids of the wound, instead of shedding them. In the *British Medical Journal* of 14th January, 1871, he wrote:—"Hitherto I have been opposed to porous antiseptic dressings, having observed that, when in the form of lint steeped in an oily solution of carbolic acid, the discharge, if at all free, washed out the antiseptic

liquid from the neutral fibres, and opened a way for the penetration of putrefaction; but having heard reports from various quarters of the efficacy of oakum, I have lately put it to the test with granulating sores where, if it should happen to fail, no mischief would result, and I have found it more than answer my expectations. The reason for its superiority over oily cloths is readily intelligible, each fibre of the oakum is imbued with an insoluble vehicle of the antiseptic; so that the discharge, in passing among the fibres, cannot wash out the agent any more than it can when flowing beneath the lac plaster, to a narrow strip of which an individual oakum fibre is fairly comparable. I may remark, as worthy of notice by those who still cling to the idea that carbolic acid has some unknown virtue distinct from its antiseptic property, that oakum contains none of that substance, but creasote, and probably other antiseptic hydro-carbons, the effects of which in preserving smoked meat are familiar." The material selected by him, and still used all over the world, either impregnated with some antiseptic material or sterilized by heat, was a cheap muslin of open texture, known in trade as "book-muslin." This was charged with resin, paraffin and carbolic acid. Resin, which is one of the principal constituents of ordinary oakum, holds

carbolic acid mixed with it with great tenacity, so that a mixture of one part to five does not, if applied to the tongue, produce any undue sense of pungency. But such a mixture is very sticky, as well as apt to be irritating to many skins. Paraffin was therefore added with a view to correct such defects. The melted ingredients were mixed in the proportion of one part of the acid to four respectively of resin and paraffin, and the mixture was diffused through the fibres of the cloth. This antiseptic gauze had carbolic acid thus fixed in every fibre, while the fine spaces between, which give its porous character to the cloth, were still open for the discharge to pass through. It was folded in such a way as to make a thickness of eight plies, and placed over the wound, overlapping it widely in all directions. But, in order to prevent fluids from going straight through the eight plies of gauze, and possibly exhausting its antiseptic ingredient, a piece of very thin mackintosh or jaconet, previously washed in the antiseptic lotion, was incorporated with the mass of gauze by being slipped under its top layer, thus leaving seven layers of the gauze next the wound, and compelling the discharges to make their way to the margins of the dressing, instead of coming straight through. Over the wound was placed, as before, a piece of the "protective plaster"; over

that, a layer of gauze wrung out of the five per cent. solution of the carbolic acid, then the dressing as I have just described it, and the whole was fixed in position by bandages made of the antiseptic gauze.

The application of the antiseptic principle to wounds led to the abolition of the metallic suture, and a return to the far more convenient threads formerly in use, but which now no longer caused any of the inflammatory disturbance and suppuration which used to be the invariable attendants of their presence for a few days among the tissues. The silk was rendered, at first, antiseptic by being impregnated with a mixture of carbolic acid and melted bees-wax, and afterwards by being simply kept constantly immersed in a five per cent. solution of the carbolic acid. The common pin was found quite unsuitable for gauze dressings, and this was the occasion of the introduction into surgical practice of the safety pin, the use of which is now universal.

Two novel additions were made to the treatment about the same time as gauze was first used, viz., the antiseptic spray, and the employment of drainage tubes. Anxious as he had always been to bring carbolic acid as little into contact with wounded surfaces as possible, and therefore equally anxious to give up the washing of the wound

prior to stitching it, if he were quite sure that harm would not result, Lister conceived the idea of rendering the ordinary atmosphere with its dust innocuous by a finely divided spray of carbolic acid; thus trying to avoid the risk of air infection, which he still believed to be a serious danger. From this time until 1890, all wounds were made and all dressings changed under its protection. With the very perfect steam spray-producing instruments which he ultimately devised, kept at a distance from the wound, wetting of the parts scarcely occurred, and while it is true that the spray may be said to have always produced a fine irrigation of the wound and its surroundings, it certainly acted far less potently on the cut surface than the actual washing with solution had done. Of the discontinuance of the spray as a part of the treatment, Lister made the following remarks in his Presidential Address to the British Association in 1896. After a reference to some experiments which he had made, he said: —"Hence I was led to conclude that it was the grosser forms of septic mischief, rather than microbes in the attenuated form in which they exist in the atmosphere, that we have to dread in surgical practice; and at the London International Medical Congress in 1881, I hinted, when describing the experiments I have alluded to, that it

might turn out possible to disregard altogether the atmospheric dust. But greatly as I should have rejoiced at such a simplification of our procedure, if justifiable, I did not then venture to test it in practice. I knew that with the safeguards which we then employed, I could ensure the safety of my patients, and I did not dare to imperil it by relaxing them. . . . Nine years later, however, at the Berlin Congress of 1890, I was able to bring forward what was, I believe, absolute demonstration of the harmlessness of the atmospheric dust in surgical operations. This conclusion has been justified by subsequent experience; the irritation of the wound by antiseptic irrigation and washing may therefore now be avoided and Nature left quite undisturbed to carry out her best methods of repair."

A considerable flow of blood and serum is sure to follow immediately upon the infliction of the wound however subsequently managed; and it is to be remembered that, at the stage of wound-treatment of which I now speak, this was much increased by the stimulating effect of the antiseptic fluid applied to its surface, even although the endeavour was always made to reduce this to a minimum. Further, we had not then the great advantage of pressure forceps, the use of which enables us to staunch by a few minutes' pressure,

and, if thought necessary, to tie all the numerous small bleeding points. Lister was at first in the habit of introducing and retaining for at least forty-eight hours or so, at one angle of the wound, for the purpose of avoiding accumulations of these discharges, a strip of lint soaked in a solution of carbolic acid and oil (1 to 4). He afterwards adopted the use of india rubber drainage tubes, with which we are now so familiar. These were devised by the French surgeon, Chassaignac, early in the century, for carrying off pus. Their employment proved a valuable addition to the antiseptic treatment. They were, of course, kept constantly immersed in a strong solution of carbolic acid. Other means of drainage were from time to time suggested, but none, so far as I know, have persisted in favour. Knowing that a drain need not be a tube in order to act, and wishing to avoid "the necessity of dressing a case solely to shorten the tube," Mr. Chiene, of Edinburgh, used skeins of absorbable prepared gut, leaving them until the ends hanging from the wound detached themselves in consequence of the absorption of that portion which was inside the wound. Others suggested horse hair for catgut, as being more economical, although not absorbable. Some time later Neuber introduced absorbable decalcified bone tubes, made from the bones of oxen,

and kept ready for use in a suitable antiseptic; while Dr. Macewen employed for the same purpose decalcified chicken and rabbit bones in his practice in the Royal Infirmary of Glasgow.

In the early eighties Koch's researches had drawn attention to the great value of the solutions of corrosive sublimate as a germicide, and very soon in many cliniques, not only in Germany, but also in this and other countries, it became extensively substituted for phenol in wound-treatment. Always open to conviction, and anxious to favour progress in any direction, so long as the progress was real, Lister himself largely experimented with the new antiseptic, and sought to find some mercurial preparation which might be substituted for the mixture of carbolic acid, resin and paraffin in the gauze. For a mercurial compound, if satisfactory otherwise, would have this great advantage over carbolic acid that, not being volatile, it would remain for an indefinite period in a dressing containing it, whereas carbolic acid is being perpetually dissipated by evaporation, and in order to avoid the chance of this occurring to a dangerous degree, the dressing has to be changed more frequently than might otherwise be desirable. For several years he toiled at this task. He found, to use his own words, that "when corrosive sublimate precipitates albumen, the precipitate is

not, as has generally been supposed, an albuminate of mercury—that is to say, a combination of albumen as an acid with mercury as a base; in other words, that the albumen does not displace the chlorine from the combination, but that the bichloride of mercury retains its properties intact, the albumen being loosely associated with it in a species of solid solution, if I may so speak" (*Lancet*, 1889, p. 943). It was further found that this loose compound was soluble in blood serum (that of the horse being employed), and also that the sublimated serum, if dried, could be re-dissolved in more serum, still retaining in solution the antiseptic properties of corrosive sublimate. Hence, if a solution of corrosive sublimate in serum of any strength that might be desirable was diffused through gauze and dried, it would in the dried state serve as a store of the antiseptic, which would be slowly dissolved by the serous discharge from the wound, communicating to it its antiseptic properties. Such was the origin of the sero-sublimate gauze, which was the first of a series of antiseptic gauzes, to each of which in turn was given a trial in the treatment of wounds, in substitution for carbolic gauze. Although good results were got from its use, the sero-sublimate gauze exhibited certain marked defects, being somewhat harsh and not very absorbent. Sal

advised that at least the portion of gauze next the wound should be moistened with a five per cent. solution of carbolic acid. Corrosive sublimate solution should not be used for this purpose, since the latter forms with the double cyanide of mercury and zinc, a triple salt which, as Lister has told us, is an extremely irritating substance.

It was a further advantage from the use of the cyanide gauze that the mackintosh covering could be dispensed with, so that the gauze becomes in a very short time a dry dressing.

Lastly, it may be mentioned that, as was pointed out by Lister in a post-graduate lecture in 1893, gauze, though convenient, is by no means necessary for a cyanide dressing. A folded towel or mass of rag, wet with carbolic lotion, can be readily charged with the dyed cyanide, uniformity of distribution being not at all essential, and excess of the salt at any part being of no disadvantage.

Altogether the double cyanide is remarkably suited for the purposes of antiseptic surgery.

NOTE BY LORD LISTER.

I have often regretted that the double cyanide of mercury and zinc is not more generally employed, especially in foreign countries. This is, I feel sure, due to want of acquaintance with it; and I avail myself of the opportunity kindly afforded me by Sir Hector Cameron of saying a few words here regarding its nature, mode of preparation and use.

Professor Dunstan, of the Imperial Institute, who most kindly undertook to investigate its composition, found it to be a double salt of very unusual type, being a tetrazincic monomercuric decacyanide, $Zn_4Hg(CN_{10})$. Its insolubility in water appears to be also a very unusual feature in a double salt. (See *Journal of the Chemical Society* for 1892.)

Messrs. T. Morson & Son (of Elm Street, Gray's Inn Road, London, W.C.), to whom I am much indebted for the great pains they have

taken in the preparation of the salt, have given me for publication the following formula:

Pot. Cyanid. 98 %	-	46 parts.
Hydrarg. Cyanid.	-	88 „
Dissolve in water	-	240 „
Zinc. Sulphat. -	-	102 „
Dissolve in water	-	120 „

When the solutions are cooled to about 60° F., mix, collect the precipitate, and wash until no precipitate occurs with Ammon. Sulphid.

The white powder so obtained is dyed with Rosalane, ¼ oz. being used to colour 4 lbs. of the powder. I tried various aniline and other dyes, and found none that answered its purpose in all respects so perfectly as purified Rosalane (as supplied by Messrs. Meister, Lucius & Brüning, of Hoechst on Main). Its principal object is to attach the cyanide to a fabric charged with it, and this it does with absolute security. At the same time the colour which it imparts to the white powder has the important effect of indicating the presence and distribution of the salt in the fabric.

Gauze may be charged by drawing it in several thicknesses through a five per cent. solution of carbolic acid in which the dyed cyanide is diffused in sufficient quantity to be about three per cent. of the weight of the dry gauze, the liquid being

constantly stirred to prevent deposition of the heavy salt.

Old rags or other absorbent fabrics can be readily charged by dipping several layers of them in the five per cent. solution of phenol and dusting one surface with an excess of the powder, which is then diffused by folding the mass and pressing it till a pretty uniform tint is produced. The absolutely unirritating character of the double cyanide makes a little excess of it in any parts a matter of indifference.

The solution of carbolic acid is used because the cyanide powder is much more readily diffused in it than it is in water, while it destroys any microbes present in the gauze as it comes from the manufacturer. The solution of phenol has the further advantage that it does not receive the slightest colour from the dyed cyanide, so that the depth of tint of the fabric charged with it is in exact proportion to the amount of the salt it contains.

The gauze, as supplied by the chemist, is dry, and having lost the carbolic acid used in charging it, may have been subsequently contaminated with septic material. The double cyanide, though very remarkable for its inhibitory power over bacteric development, is without efficacy as a germicide; and the microbes in the contaminating material would be free to develop in the deep parts of

the gauze as soon as the cyanide in them had been exhausted. In case of moderate discharge, this would probably never occur, thanks to the slight solubility of the salt and its secure fixation by the dye. But in case of copious effusion of blood and serum, the salt would in time be exhausted and the microbes in the infective material would be free to develop. In order to guard against this risk, the dressing may either be damped throughout with the carbolic lotion, or, as ample experience has proved to be sufficient, a portion of the gauze in several layers, soaked with the lotion, may be applied over and around the wound and the rest of the dressing used dry.

Bichloride of mercury must not be employed for moistening the gauze, because it forms with the double cyanide a triple compound which is both feebly germicidal and highly irritating.

The double cyanide might, I believe, be very satisfactorily used in military practice as a first dressing, by dusting it over the wound with a pepper box, and covering with any absorbent material that might be at hand. The salt might be used with the utmost freedom, as experience has shown that there is no risk of its producing poisonous effects. Some surgeons who undertook to use the cyanide in this way in the late South African war, had unfortunately no opportunity of

doing so at the front. But Mr. Cheatle informed me that granulating wounds behaved more satisfactorily with the cyanide than with iodoform, while the unpleasant odour of the latter was of course avoided. For further particulars regarding the use of the double cyanide I would refer to an "Address on the Antiseptic Treatment of Wounds," published in the *British Medical Journal* for January 28th, February 11th and February 18th, 1893. The part in the number for February 18th contains the reference to the double cyanide.

LECTURE II.

HAVING traced in my former lecture the progressive steps and changes in the methods of antiseptic dressing from the commencement of the treatment until Lord Lister retired from practice, I shall immediately refer to the reaction which began about fifteen or twenty years ago against the use of chemical antiseptics, and in favour, so far as possible, of sterilization by heat of everything used in wound-treatment. But before doing so, it will be convenient to refer to certain criticisms which one reads and hears by many of those who adopt this latter plan of seeking aseptic results—criticisms which, although made doubtless in all good faith, do not seem to me to show always a very exact knowledge of what the forms of practice which I have described to you really were.

One common belief is that, in his earliest efforts, Lister, fearing as he did the influence of the atmospheric dust with its contained organisms,

endeavoured to exclude air from wounds altogether, and so sealed them up by means of dressings—the putty and the lac plaster—which were impervious to exuding fluids, and adhered closely to the surface of the body. Thus Schimmelbusch says:—"The best means of protecting a wound from the dangers which threaten from without might, *a priori*, appear to be to close it up as closely and firmly as possible. A completely impermeable dressing was one of Lister's ideas. The dressing which he first made use of to effect his object was a kind of putty made of common whiting and linseed oil such as glaziers use, to which was added carbolic acid. This was laid over the wound smoothly and closely, and covered with a piece of sheet block tin." He then describes methods of permanently sealing up a recent and clean-cut wound by unirritating strapping or by collodion with or without gauze; and adds, "either plan will probably be preferred now-a-days to the use of putty and tin foil." "But the number of wounds," he continues, "that can be so treated must always remain very small, for success is possible only when there is no secretion from the wound. If it secretes only a moderate amount of fluid, sealing is futile and even dangerous. The secretion, which consists of blood or lymph exuded after the dressing is

applied, collects under the impermeable covering, breaks through the weak spots in the covering, and soon decomposes" (*The Aseptic Treatment of Wounds*, by Dr. C. Schimmelbusch, translated from the second German edition by Alfred Theodore Rake, M.B., p. 83). I have thus quoted at some length, because this mode of criticism is one which I have often heard, and one which has no justification in fact. It is an entire misconception of Lister's meaning and method. The covering of block tin was simply used to check the evaporation of the volatile antiseptic. The putty permitted all wound fluids to flow freely between its surface and the skin into absorbent materials specially arranged outside for their reception. Constantly giving off carbolic acid, it maintained an antiseptic atmosphere in the space between itself and the skin, even in parts where these might not be in direct contact, and being made sufficiently large to overlap the wound widely, it securely prevented the access of sepsis up the stream of fluid discharge. The lac plaster, the use of which supplanted that of the putty, was coated with india rubber, with the express purpose of preventing its adhesion to the skin, and the consequent sealing of the wound. A drain of lint, steeped in carbolic acid and oil, was introduced into every abscess cavity when opened,

and into every wound of importance, while for this was latterly substituted the constant use of drainage tubes. Lister was, from the first, well aware that he could not exclude air from wounds, even if he would; and he was also equally well aware of the supreme importance of avoiding the distension of wounds by the accumulation of fluids. This he taught in season and out of season, and so far from crediting him with any desire to seal up wounds, I should rather contend that he was the first to advocate complete and constant drainage, with, of course, the proviso that the fluids in the course of their escape must be guarded from all septic influences from without. Further, the very dressing which is now used as the extreme opposite of anything which seals, since it is something which constantly absorbs, viz., gauze, and which meets with such approval on that account, was, as I have already said, a suggestion of Lister's.

Another criticism is the frequently repeated one that, in those earlier days of antiseptic treatment, it was believed that the atmosphere with its dust was the only source of wound infection. This is a strange misconception. If mischievous contamination of wounds could result from exposure to the microbes of the atmospheric dust—and of this, in the then existing state of knowledge, no

besides those of putrefaction, for I am satisfied that inodorous ferments sometimes occur in the animal fluids, and produce salts which stimulate to suppuration; also viruses inducing suppuration are very probably of the same essential nature (ferments), though some at least are odourless, as in the case of erysipelas" ("Remarks on a Case of Compound Dislocation of the Ankle, with other Injuries; illustrating the Antiseptic System of Treatment." The *Lancet*, March 19th and 26th, and April 9th, 1870). Mr. Watson Cheyne in his article entitled "Listerism and the Development of Operative Treatment," in the *British Medical Journal* of 13th December, 1902, writes of this same matter as follows:— "At that time (*i.e.* 1872) the scientific basis on which the Listerian system was founded was very crude. Septic conditions were looked at as essentially of a putrefactive nature, and when putrefaction was absent, sepsis was looked on as also absent. But even at that time, and before I had completed my studentship, Lord Lister was beginning to conclude from his operative work, and the observations made on his wounds, that this was too narrow a generalization, and that these organisms must be of a great variety of species, and that the association of putrefaction was not essential to even the most serious forms

of sepsis. He was coming to the conclusion that different species of organisms must be accountable for different septic diseases, and I well remember his timidly putting forward the view that even tetanus was probably due to an organism, because he had not had a case of tetanus for many years, although previously it was quite a common disease. Lord Lister himself probably provided the first complete demonstration of the existence of distinct species of fermentative organisms in his researches on lactic fermentation, when he was able, by a very ingenious device, to separate a single organism—the bacillus lactis—which produced this fermentation and no other." In his Presidential Address to the British Association, at Liverpool, in 1896, Lord Lister himself said:—"The striking results of the application of the germ theory to surgery acted as a powerful stimulus to the investigation of the nature of the micro-organisms concerned, and it soon appeared that putrefaction was by no means the only evil of microbic origin to which wounds were liable. I had myself very early noticed that hospital gangrene was not necessarily attended by any unpleasant odour, and I afterwards made a similar observation regarding the matter formed in a remarkable epidemic of erysipelas in Edinburgh, evidently of infectious character. I had also seen

a careless dressing followed by the occurrence of suppuration without putrefaction. And as these non-putrefactive ailments had the self-same propagating property as ferments, and were suppressed by the same antiseptic agencies which were used for combating the putrefactive microbes, I did not doubt that they were of an analogous origin, and I ventured to express the view that, just as the various fermentations had each its special microbe, so it might be with the various complications of wounds. This surmise was afterwards amply verified."

Another frequent criticism is, that one great objection to the antiseptic method of dressing, as taught by Lister, is that the dressing is a moist one, for we know that moisture favours the development of the germs which cause wound infection, while dryness, as perfect as possible, has precisely the opposite effect. Under efficient antiseptic management, however, it is a matter of indifference whether the material applied be dry or wet. This is well illustrated by the equally satisfactory results obtained by the carbolic gauze, kept more or less damp by the sheet of mackintosh under its outer fold, while the edges of the wound were always moist under the protective, and by the cyanide gauze where the dressing was a dry one, after the short time required for dissipating the

solution of carbolic acid with which the part next the wound was moistened.

Another objection often stated is the assumed fact that the carbolic acid necessarily caused poisoning of the patient's system, and by its local application interfered with the power of resistance or self-defence against the influence of septic microbes possessed by the living organism. This protective power was both known and respected by Lister, who used to say that, previous to antiseptic treatment, surgery would have been impossible without it. He endeavoured, after the first dressing, always to avoid any direct contact of the antiseptic with the wound. The whole ideal of the treatment as I have detailed it to you, was to permit the wound to progress like a subcutaneous injury free from external stimulation, whether septic or antiseptic. It is true that, believing as he did in the risk of infection from the atmosphere, it was his invariable practice for many years to wash the surface of the wound with an antiseptic solution, before stitching and dressing it. But the washing he employed was on that one occasion only. When dealing with abscess, no antiseptic was ever introduced into the cavity at all. It was far otherwise with many of those who counted themselves amongst his disciples and imitators. Not perhaps thoroughly

appreciating the scientific facts which were the basis of the treatment, they were unable to divest themselves of the old idea, that, whatever was used in the treatment of a wound, was necessarily intended to have some specific effect on its healing. It could not, therefore, be brought too freely or too often into contact with it. They filled kettles with carbolic solutions, and poured them over wounded surfaces or injected these same solutions into all interstices of wounds with syringes, while abscesses, empyemata and the like, were freely syringed out in the same manner at the time of operation, as well as at every subsequent dressing. This was the kind of practice which prevailed widely in supposed imitation of Lister. One saw it equally in the wards of colleagues who worked under the same roof as himself, and in those of surgeons at a distance, both at home and abroad. It is little marvel that this reckless and constant pouring and splashing about of carbolic solutions was found to have injurious effects on the healing process, as well as to be poisonous to many patients.

The excessive use of antiseptics, with the disadvantages which it obviously entailed, led in time to the wide adoption of those methods of treatment which endeavour to dispense, as far

as possible, with chemical agents, and to substitute for them the employment of heat, by which instruments and dressings are sterilized. It is in my opinion to be regretted that this form of treatment, which involves no new principle, but only a change of procedure, should have received a distinguishing name, and should be spoken of as if it was represented by a different school of thought and of practice. Every treatment which is directed against sepsis, no matter what the means be which are employed, is surely *antiseptic* treatment. The word *aseptic* was devised by Lister to denote the condition of a wound from which sepsis is absent. In the earlier days of antiseptic treatment, surgeons used to speak of a wound as being "in an antiseptic condition," or an operation as being followed by "a thoroughly antiseptic result"; and anyone who chooses to turn back to the medical journals of the period will find such expressions in their pages. It was in order to avoid such awkward phraseology that Lister suggested the adoption of the word *aseptic*, a word which he afterwards found had been used by Hippocrates. To speak of the "aseptic treatment of wounds" is clearly as confused and inelegant as to speak of "the antiseptic condition of wounds."

Lister was probably the first to use a dressing

antiseptic principle were of the utmost simplicity, and could be employed with complete confidence of aseptic results by the private practitioner under any surroundings equally with a hospital surgeon. The spray, however, was by no means useless. Being far less irritating to the wound than washing with carbolic lotion, it greatly reduced the serous discharge, and with it the amount of drainage necessary. But by far the most important service rendered by the spray was the proof which it finally afforded of the innocuousness of the atmosphere. To this conclusion Lister had long been inclined. At the London Congress in 1881, after describing some experiments that he had recently made which proved that putrefactive bacteria, if widely diffused by means of water sterilized by heat, are incapable of development in normal serum, made the following statement: —"The facts seemed to indicate that the putrefaction so apt to occur in wounds not treated antiseptically, is due rather to septic matter in a concentrated form, than to septic matter in the diffused condition in which it exists, either in water or in air. In other words, is there sufficient chance of the air of an operating theatre or private room containing septic matter which can prove effective in blood serum to make it needful to regard the question of contamina-

tion from the atmosphere at all?" *Transactions of London Medical Congress*, 1881, vol. ii., p. 372).

But he did not dare to omit the spray without positive proof that this could be done with perfect safety. Of that he was at length fully assured by a consideration of the physical constitution of the spray, coupled with the success that had attended its use through many years, in spite of the entire abandonment of other precautions against the atmosphere which, before the introduction of the spray, he had deemed essential. Especially instructive in this respect was his experience with empyema. Before the spray, he had always covered the wound during the evacuation of the pus, and at subsequent dressings, with a piece of lint soaked with a strong solution of carbolic acid, to prevent the entrance of air into the pleural cavity during inspiration. Under the spray this was discarded, and the patient was allowed to draw air freely into the pleura, both during the operation and subsequently. Yet this change, while it greatly simplified the procedure, in no way interfered with the constancy of what he used to regard as perhaps the most beautiful of all the results of antiseptic treatment. The evacuation of the original pus was followed by merely serous discharge which, copious at first,

diminished rapidly in quantity and, though cases differed as to the period at which the drainage-tube could be removed, healing invariably occurred sooner or later. The pleura then having recovered its normal functions, absorbed the air it contained, and the lung, just as in pneumothorax from puncture by a fractured rib, was restored by atmospheric pressure through the trachea to its natural dimensions, while the thorax on the affected side retained its original contour uncontracted.

During the protracted period that often elapsed before complete healing, multitudes of atmospheric microbes had at every dressing been drawn with vitality unimpaired into the pleura, where they were securely protected against any action of the antiseptic, but never occasioned the slightest inconvenience.

These facts, occurring as they did under ordinary conditions of hospital theatres and wards, or of private rooms, seemed to Lister conclusive evidence of the harmlessness of the air in operations. (See *Transactions of the Berlin Medical Congress*, 1890; also *British Medical Journal*, August 16th, 1890.)

One of the great aims of those who use dressings composed of gauze sterilized by heat, is to secure a very dry condition of the wound before

closing it up; and many tell us that, if this be done, even large wounds like those now made in operating upon the female breast for cancerous disease may be closed without drainage, while no fear need be entertained either of the retention of wound products, or of any undue saturation of the dressings. I have no doubt that, with some painstaking as regards hæmostasis, and the careful adjustment and co-aptation of opposing surfaces, such a result may often be attained, but my experience leads me to doubt whether this could be relied upon in any given case. One patient when wounded differs from another in the matter of persistence of oozing of blood. Pull a tooth, and, in one man the empty socket will cease bleeding in half an hour or less, while in another it will ooze for a couple of days or longer, and that without any question of peculiar diathesis. But diathesis and varying conditions of health must also be considered. Some years ago I tied the femoral artery at the apex of Scarpa's triangle, in the case of a professional brother who was well-known to many of you. He had been for a considerable time in bad health, and for some months had been confined to bed. He suffered from some form of anæmia, and constantly complained of a sense of great weakness. When in bed he one day discovered an aneurysm at the

back of one of his knees. After tying the femoral artery, I saw no vessels, in the comparatively small wound, demanding ligature, but a persistent flow of blood-stained fluid from all its surface made me introduce a small drainage tube. Such a wound may, no doubt, be generally left without drainage, and, if aseptic, will heal at once. But in this case, for a whole week a fluid like cherry juice kept constantly exuding, so that I had to change the double cyanide gauze with which I dressed the wound every second day during that week. I was then able, from diminished exudation, to withdraw the drainage tube. The wound healed at once, and permanently, without a drop of pus-formation. The aneurysm consolidated, and ultimately became cured. A cerebral hæmorrhage, however, took place in less than a year afterwards, and caused my friend's death, after a few hours' illness. In such a case I cannot believe that it would have been possible by any means to secure a dry wound, and there must be, under such circumstances, great risk in using heat-sterilized gauze as a dressing, no matter how great a mass of it be employed. It is obvious that no disadvantage can arise from the fact that the gauze contains an antiseptic in its substance, provided it causes neither local irritation nor general intoxication, and the presence of the antiseptic

undoubtedly adds greatly to the security of an aseptic result.

For preliminary sterilizing of the patient's skin around the seat of operation, surgeons at the present day differ greatly as to the character and complexity of the methods they employ. Lister, till he gave up operating in 1896, continued the simple procedure which he adopted thirty years before; and he informs me that he never had any reason to doubt its efficacy. This consisted of washing the surface freely with a one to twenty watery solution of carbolic acid, and keeping it covered with a piece of lint or other cloth soaked with the same lotion during the interval between the washing and the performance of the operation. That interval was never made by his directions a protracted one. In private practice the washing was done when he entered the patient's room, and the operation was proceeded with as soon as the instruments had been got ready, and the anæsthetic administered. He never took any steps for ridding the skin of greasy impurity, or epidermic débris. The great affinity which carbolic acid has for most organic substances, including the fixed oils and epidermis, made any such measures, in his opinion, wholly unnecessary. The contrast between oil and water in their relations to carbolic acid was referred to in an

instructive manner by Lister in the course of a demonstration on antiseptic surgery at the Richmond Hospital in Dublin in 1879. "A new principle in pharmacy," he said, "seems to have been brought out by our experience with this agent. I believe it is generally assumed by pharmacists that the strength of any given agent in its action depends upon the proportion in which it is present in the vehicle, or solvent—that if the agent exists in twice as great amount, it will be twice as strong in action. Now that is true with the same solvent, but it is not true with different solvents. Thus carbolic acid is soluble in twenty parts of water, but oil can be mixed with it in any proportion. Suppose you compare a one in twenty solution in water with a solution of one part of carbolic acid in five of oil; you will find that the solution of one in twenty in water is more powerful in its immediate action than a solution of one in five parts of oil. The solution in oil contains four times as much of the agent as the watery solution, and yet is not so powerful in its action. You can bear the one to five oily solution applied to your tongue tip, or the thin skin of the lip, better than you can the one to twenty watery solution, and the one to twenty solution in oil is so bland, that it can be used for smearing a catheter without irritating the delicate mucous membrane of the

urethra, to which the one to twenty watery solution would be intolerable. Now, the reason appears to be simply that water holds the carbolic acid feebly, and so lets it readily fly off to attack anything else." (*Dublin Journal of Medical Science*, 1879, vol. ii., p. 99.) And so he taught that the one to twenty solution readily and at once penetrates the greasy epidermis, and is very powerful in its immediate action upon it, but as there is not a large quantity of it present, that action is comparatively transient.

The avidity with which carbolic acid seizes upon epidermic tissues was strikingly illustrated by an experiment which he related in an unpublished address to the medical students of Glasgow, delivered in 1894.

Having discovered a method by which the amount of carbolic acid present in a watery solution could be determined,[1] he packed a test

[1] In the course of some work on the preparation of cat-gut for surgical purposes, he observed that if a weak solution of chromic acid in water is mixed with carbolic lotion, the mixture, which is at first a pale straw colour, gradually grows very much darker during the next few hours. This fact afforded the means of estimating the quantity of carbolic acid in a watery solution. Making a mixture of equal parts of the weak chromic liquid and a five per cent. watery solution of carbolic acid to serve as a standard of comparison, and at the same time making a corresponding mixture of the chromic

tube closely with hair of the human head, and added just enough five per cent. solution of carbolic acid to cover it, eight times the weight of the hair being required for the purpose. Half an hour later he poured out some of the liquid, and applied the test; when it was found that already nearly half the carbolic acid had been withdrawn by the hair from the watery solution.

Considering that the hair was only an eighth part of the weight of the solution, this was certainly very remarkable. The hair must thus have become charged with about a sixth of its weight of the antiseptic; and if a larger quantity of the lotion had been used, the proportion would have been still greater.[1]

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liquid with the carbolic solution to be tested, and ascertaining how much the standard had to be diluted in order to bring its tint down to equality with that of the mixture containing the liquid to be tested, an estimate could be formed of the amount of carbolic acid present in the latter. Lord Lister informs me that, on going over the subject again recently, he ascertained that hair retains this remarkable power of withdrawing carbolic acid from a watery solution after all fatty matter has been removed from it by prolonged steeping in sulphuric ether.

[1] Hair thus highly charged with carbolic acid by washing with five per cent. solution, may sometimes be turned to account in surgery of the scalp as an effective and unirritating antiseptic dressing. This may be illustrated by one of Lord Lister's

In such strength it could not fail to act powerfully as a germicide on any microbes which the hair might contain; and this applies equally to the epidermis. A knowledge of these facts, coupled with the constancy of aseptic results obtained by Lord Lister, which has probably never been surpassed, may well make us content with his simple method of purifying the skin.

My own practice is to insist upon a dressing of one to twenty watery solution of phenol being applied widely over the part to be operated on for half an hour or an hour before the operation takes place, no matter what preparation of the skin, if any, has been made. As a matter of fact, we operate in our Glasgow hospitals at an early morning hour, and my nurses always prepare the skin on the previous evening, washing it with warm water and soap, and afterwards cleansing it with turpentine and spirit. This is, I believe,

latest cases. The patient was a lady with numerous atheromatous tumours scattered over the scalp. To have shaved around each of these would have caused a very inconvenient loss of hair; but this was avoided by washing freely with the lotion about each tumour, and simply passing a comb along the line where the incision was to run, the hair being replaced in position after the removal of the cyst. The several tumours having been so dealt with, a cap of folded cyanide gauze was bandaged over the head, and when this was removed some days later, all the wounds were found to be healed.

the lotion was not applied further to the hands, unless some unusual circumstance involved their contact with objects likely to defile them.

For sterilizing instruments, our practice is to boil them for twenty minutes or half-an-hour, except in the case of knives, which may be placed in a one to twenty carbolic solution for some time before being used.

Lord Lister informs me that he always trusted to placing the instruments in the five per cent. solution immediately before the administration of the anæsthetic. There can be no question that this is more convenient than boiling, especially for private practice, provided that it is really reliable. This Lord Lister's long experience seems to place beyond doubt. But, as he remarks, it is essential that the instruments be thoroughly immersed. He tells me that in the few cases in which he has witnessed operations in private practice by others, the layer of carbolic lotion has been too shallow to cover the instruments completely. They might almost as well have been left without any attempt at sterilization. In hospital practice this is much less likely to occur, even although the trays employed be broad, since abundance of the lotion is always at hand. For his private practice he used a narrow but deep tray, not requiring much of the solution to fill

it, sufficiently long to accommodate all instruments except saws and long amputating knives. These were wrapped in lint soaked with the lotion at the same time that the other instruments were placed in the tray. The teeth of saws and forceps were always brushed clean before being put away after the operation.

In the case of compound fracture, I cannot believe that the application of chemical antiseptics to the wound can be safely omitted. That it should be entirely discarded is the advice given by Professor von Bergmann in a recent article on the subject, written by him in the volume on *First Aid in Surgical Cases*, edited by Meyer. He strongly objects to any antiseptic solutions being used to purify the wound itself, limiting such use entirely to the purification of the surgeon's own hands and the skin of the wounded limb. "I advise," he writes, "that every wound be purified dry, and not with antiseptic fluid—an advice which is, of course, opposed to that which was at one time warmly recommended." And again, "in compound fractures, for which Volkmann required washings out with streams of carbolic solution, the same principles hold good which have been already in part developed in reference to the general treatment of wounds." He then recommends that the skin of the limb

should be cleansed and afterwards disinfected with corrosive sublimate, the wound being temporarily plugged with sterile gauze during the process. He trusts entirely to the protective power of the living organism for defence against such microbes as may have entered. This he does even in cases where a fragment may have protruded, and come into contact with clothing, or been otherwise defiled, and then been reduced. In severe compound fractures, he is very insistent upon the stopping of all bleeding and the formation of counter-openings, "so that the wound products may escape by the most direct and shortest route." "When the walls," he writes, "of what is often an immense wound have ceased to bleed, or bleed only slightly, and the counter openings have been made, they are dabbed all over with swabs of crèpe gauze—that is our cleansing. The swab takes up what there is of dust and dirt still adhering to the wounded surfaces, and removes it. The out-flow and oozing of the blood provides for the more complete separation, shedding and removal of injurious matters, dead or alive, by washing them out, and carrying them by the deepest parts of the wound to the surface. Syringing is dangerous, in-as-much as it drives the dirt, and the bearers of infection, into the deeper interstices of the tissues. In addition, we have

the irritating action of antiseptics which causes the recesses of the wound to be filled with additional exudations, and these as dead stagnant fluids, furnish an excellent nutrient medium for the growth of bacteria. For certain bacteria which make their way into every wound, but specially those complicated by injuries of bone, the protective action of the tissues themselves is competent to deal. But for many micro-organisms, that grow in putrid fluids and become very virulent there, these powers of our tissues do not suffice. In a dry wound bacteria may remain, and will soon die; but, in the fluids within the wound, which are the best growing medium for them, they increase until they are ripe to attack the cells of the organism. Therefore I insist again upon the laborious and careful arrest of bleeding before cleansing the wound. (*Erste ärztliche Hülfe*, edited by Meyer.) It may seem presumptuous to join issue with so great a surgical authority as Professor von Bergmann in regard to a matter of such vital importance as the treatment of compound fracture; but I have no hesitation in saying, after an experience as a surgeon for more than thirty years in Glasgow hospitals, that no mere toilet by dry sterilized cloths, apart from germicidal solutions, will be sufficient, in our patients, to prevent sepsis and

suppuration in fractures, where the end of a fragment and the wound, one or other or both, have been defiled by contact with skin, clothing, the dust of machinery, or the mud of the street. I can further say that I have always washed out such wounds freely with a solution of five per cent. phenol, and I have never been conscious of any of the evils which von Bergmann dreads. In the last few weeks I have treated four compound fractures of both bones of the leg, each of them certainly with a comparatively small external wound, but all produced by great violence, causing much blood extravasation and distension of the limb, as well as in three of them extensive vesication of the skin. All were freely injected with one to twenty carbolic acid solution, and after the skin of the leg and foot had been thoroughly disinfected, they were dressed with double cyanide gauze. All have progressed like simple fractures. Bleeding was fairly free in all of them, saturating the antiseptic gauze in the first twenty-four or forty-eight hours. At the end of that time the internal wound was in each filled with a clot, which was on a level with the edges of the wound in the skin, and which became gradually organized and covered with cicatrix. In a fortnight or three weeks each was permanently put up in plaster of Paris. One of these four cases came

to us from the West Highlands twenty-four hours after the accident had occurred. I instructed my house-surgeon, when he telephoned to me for advice, to stir up the wound with a piece of gauze wet with a strong solution of phenol in spirit—say one to six—and held in a pair of dressing forceps, and thereafter to inject it as usual. This was done, and the case progressed like the others. It is very possible that in all of these cases, except perhaps that which was twenty-four hours old before being dealt with, healing might have been obtained without suppuration by simply dry-cleaning the wound according to von Bergmann's plan, disinfecting the surrounding skin, and dressing with a mass of sterile gauze. Such microbes as happened to have been introduced might have been disposed of by the defensive power of the living organism, and the wound have healed at once, as such wounds sometimes used to heal under a dry crust of blood. But I maintain that this is too doubtful an issue to be entirely trusted, especially in such cases as those I have referred to, where the wounds, although not large, were by no means mere punctures. No harm comes of adopting the measures I have described, in spite of strong statements so frequently made to the contrary. That those measures are beneficial and reliable may be still further learned by considering

I put a couple of stitches in the cut I had made, but left the irregular hole in the skin open, so that no wound-exudation should be unnecessarily retained. The result was absolutely satisfactory. The man recovered without pain, fever or suppuration, and has a movable ankle joint.

I could relate many other similar cases, but only one more will I refer to. It was the case of a carter who, in trying to stop his runaway horse, fell, and his leg becoming entangled in the wheel of the cart, he was dragged for some distance. On admission, his left knee joint was found to be dislocated, the internal condyle projecting through the skin, which tightly and firmly embraced the base of it. The entire condyle and the skin around it were thickly covered with the dirt of the street, which was ingrained into the tissues. The clothing which covered his knee had, of course, been extensively torn. Having cleansed the parts as well as possible, I pared off all tags of the soft parts remaining attached to the protruding bone, and treated the case by the method just described. Where I found dirt ingrained into the bone, I swabbed freely with undiluted carbolic acid. After enlarging the wound and reducing the dislocation, I cut away the blackened edges of the skin wound and washed out the joint with a one to twenty solution. The

patient recovered without the slightest unpleasant symptom. Within a year afterwards he was readmitted with a simple fracture of both bones of the other leg, and we had the opportunity of hearing from him, and seeing for ourselves, that his left knee was in all respects as good and serviceable as his right.

A third form of compound fracture is that in which large and severe wounds exist, while the broken and probably comminuted bones are fully exposed. Much laceration of muscles and injury of blood vessels are probably also present. We must all admit that these are more uncertain cases for treatment. They are those in which the question of amputation arises, but is decided in favour of retaining the limb. Von Bergmann prefers to trust to the dry wiping of both wounds and fragments, removing with forceps all foreign bodies and entirely detached pieces of bone, making free counter-openings, arresting hæmorrhage by ligature, if need be, and stuffing, and so preoccupying all cavities with sterile iodoform gauze. My practice is to wash out such cases and dress them, just as I do those less severely injured, wiring fragments, if it is thought desirable, and securing by ligature vessels which seem to require it. Our results have, I think, justified the treatment entirely.

I have spoken already of the organisation of blood clot in connection with aseptic compound fracture. Long ago Lister took advantage of his observations in this matter to aid him in obtaining healing where bone had been excavated in the course of operations, the cavity filling with blood, which coagulated and became organised, as in compound fracture. Volkmann afterwards published cases in which he applied this method successfully, even where he had to deal with previously existing suppuration. By the free use of his sharp spoon he removed the septic soft parts, destroying the carious bone with the thermo-cautery. Allowing blood to clot in the cavity so produced, he obtained its organisation, and consequently healing without suppuration. I have lately treated the following case, which illustrates the value of this antiseptic procedure where it is possible of accomplishment. On the 15th November, 1905, I operated, in a nursing home, in the case of a boy, aged eleven, on a tubercular ailment close to the upper epiphysis of the right tibia. The head of the bone was expanded, and an abscess tended to point over the inner side, where an area of skin, about the size of a shilling, was thin and livid. Having applied a tourniquet in the form of an elastic bandage to the thigh, I evacuated the abscess, and cut away the thin

tuberculous skin. With the sharp spoon I most carefully scraped away all granulations and caseous material in the subcutaneous space. A hole in the tibia leading into a cavity was then seen and enlarged, and from it I extracted a sequestrum about the size of the distal phalanx of one's fore-finger. With a strong sharp spoon I cleaned out the cavity, the walls of which were for the most part bare and carious, as carefully as a dentist would one in a tooth, removing portions of its walls all round, until I was satisfied I had taken away all diseased bone. Following Mr. Watson Cheyne's advice, I then soaked its walls with undiluted carbolic acid, and washed out any excess which remained with a solution of one to forty of the same acid. After dressing with a sufficient mass of cyanide gauze and applying a posterior splint, I removed the tourniquet, placing the limb in such a position that the wound was uppermost. Next day, as some blood had come through the dressing, I removed it, and found the whole wound filled with a firm clot, which was on a level with the skin edges. This I succeeded in keeping aseptic throughout the whole course of the case. No suppuration occurred, and no fever was shown by the thermometer from first to last. The clot became organised, and after some weeks its surface granulated. A cicatrix spread over it from the

edges of the skin, and by the 18th of January (a little over two months) it was almost completely healed. On that day the patient seemed to have a cold in the head, and his temperature rose to 99° Fahr. On the 19th it rose in the evening to 101.4°, and on the 20th he was covered with the rash of measles, and his temperature was 102.4. He was removed to the infectious hospital at Ruchill. When I visited him there five days afterwards, I found the wound entirely healed, and the whole region of the knee was in a very satisfactory state. On February 8th, I fixed the limb in plaster of Paris bandages, and on the 10th he was removed to his own home in the country.[1]

I mention this case as an excellent example of the immediate obliteration of a large bone cavity by the organisation of a blood clot which filled it; and this is one of the valuable means of treatment which we owe to the antiseptic method in cases which are apt to present great difficulty in

[1] In three weeks he returned and had the plaster of Paris bandages removed. The wound remained whole, and the knee could be slightly bent without pain. A flannel bandage was applied, and he was ordered to walk about with crutches, a patten being put on the boot on the sound foot. On 2nd April, he was brought back to see me, when I found the limb perfectly well, and the knee once more freely movable. For some time past he had been walking without any support, and he returned to school shortly afterwards.

the attainment of final closure. Where the skin is unbroken prior to operation, such beautiful results may be anticipated with confidence.

Many other materials have been employed for the plugging of the bone cavity with the view of acting like the clot, as a framework which new tissue, sprouting from the walls, may enter, penetrate and absorb, and become ultimately ossified. Prepared catgut, bone-fragments and marine sponge have all been used for the purpose, but I am afraid with no very encouraging success. Comparatively recently, however, Professor Moorhof, of Vienna, has devised a bone-plugging wax, the use of which appears to have yielded, both in his own hands and in those of others, more encouraging results. The walls of the cavity to be plugged must be so dealt with as to make sure they contain no diseased tissue, must be thoroughly aseptic, and must be perfectly dry. The drying is effected by hot air, driven into the cavity by a special apparatus devised for the purpose. The wax consists of a mixture of sixty parts of finely pulverized iodoform, and forty parts each of spermaceti and oil of sesame. At 112° Fahr. this mixture is fluid, and after being shaken up, is poured slowly into the cavity, in which it sets, and becomes solidified in a few minutes. The skin is stitched over it, and,

according to Professor Moorhof and others, immediate healing may with considerable confidence be expected. The wax is absorbed by newly formed tissue sprouting from the bony walls of the cavity, "the production and gradual growth of bone tissue being effected by a primary formation of new connective tissue" ("Experience with Bone-Plugging": *St. Thomas' Hospital Reports*, vol. xxxii.). Results of the best kind are said to be obtained in spite of the previous presence of suppuration and sinuses, provided that most thorough care be taken in cleansing and disinfection. The absorption of the antiseptic wax, as well as the bone formation, have been verified by the use of the Röntgen rays. Whether, therefore, it be brought about by the organization and absorption of blood clot, or by some such artificial filling as that suggested by Professor Moorhof, the immediate closure of bone cavities resulting from tuberculous disease, from the separation of sequestra following osteomyelitis, and the like, is a beautiful example of practical progress due to antiseptic surgery.

I had hoped, had time permitted, to speak at some length of the antiseptic treatment of abscess, which, as I indicated in my previous lecture, was an early development of the system which Lister introduced. The power we possess, by this treat-

ment, of guiding large tuberculous psoas or lumbar abscesses to a successful issue, is one of which I have had abundant personal experience. I could indeed produce a long list of such cases treated during the last thirty-five years, who are now well, and leading useful and active lives in many parts of the world. From time to time I have been led to vary the treatment as originally practised, when suggestions promising to shorten convalescence have been made. Thus, I have scraped out the abscess cavity thoroughly with the flushing spoon, using some sterile, but not very stimulating, fluid for the purpose. I have also injected iodoform emulsion in glycerine, sometimes associated with, and sometimes without the use of the sharp spoon. The result has been to make me adhere more confidently than ever to Lister's original plan of simple incision and drainage, combined with most scrupulous and systematized antiseptic precautions. The antiseptic gauze is changed at intervals of time determined by the amount of exudation, with all the same care that was exercised on the first occasion of evacuating the abscess. The treatment is to be continued until the final absolute closure of the wound, no matter how long that be delayed, while the patient must be kept constantly recumbent, to give due rest to that part of the spine

in which has originated the tuberculous disease. If sepsis invades the sinus from without, even months after the abscess has been opened, and a mixed infection is produced, the case may be regarded as hopeless. There is, I believe, under such circumstances, no treatment which can undo the mischief produced, or avert the fatal issue to follow sooner or later. On the other hand, if septic contamination is avoided, only a serous exudation, diminishing as time goes on, will take place, while the patient continues free from fever, and steadily increases in weight. Under such circumstances, a permanent and complete recovery may be expected. The injection of iodoform emulsion, which is often so very successful in cases of limited and accessible tubercle, as in small tubercular abscesses of the soft parts, in dactylitis, in diseases of carpal and metacarpal, of tarsal and metatarsal bones and the like, is quite futile, so far as I have seen, in the treatment of large abscesses connected with bones and joints. I fear, however, the advantages of careful antiseptic drainage of these great tuberculous collections have not been sufficiently appreciated by the majority of hospital surgeons. This is probably due to discouragement caused by failure to maintain the aseptic state in the course of the long period during which such cases must be kept in

hospital. Yet the dressing is a matter of extreme simplicity, and when the first few days have passed, may be safely entrusted to a dresser who has been duly impressed with its vital importance. To discharge such patients before healing is complete, merely because they have been long in hospital, and the serous discharge has become scanty, is surely not justifiable. If admitted at all, they must be treated with the same care until they are healed. If failure to exclude septic mischief occurs, evidenced as it will be by the supervention of hectic fever and the discharge of pus from the sinus, no reason longer exists for keeping such a patient in the hospital. His fate is sealed, no matter where or how he may be treated.[1]

I must also refer very briefly to abscess of the hip joint. Here results are obtained by antiseptic

[1] Since these lectures were delivered, reports have appeared by different surgeons of the application to surgical practice of the so-called "vaccine treatment" evolved from the beautiful researches of Sir Almroth Wright. Among the cases recorded are some of the nature referred to in the text, where cure is said to have been effected in spite of contamination of the abscess from without. A hope is thus raised that such cases may in the future lose their present hopeless character, and also that the progress towards recovery of uncontaminated cases treated antiseptically may be greatly accelerated.

powers in controlling the progress of wounds and the issues of abscesses. This I have not attempted to do in full detail, but rather tried to refer to the chief principles which guide us, and the character of the materials with which we work in carrying out these principles. It is unnecessary that I should endeavour to portray the contrast which may be easily drawn between surgery as it exists to-day, and surgery as I witnessed it on my introduction to hospital as a student. Let it suffice to say that we who practise surgery to-day do so with a confidence and a sense of safety to which the surgeons of forty-five years ago were entire strangers, and this is an outcome of the application of scientific truths. The very fact that it is such an outcome makes it as necessary now, as it was declared to be at first, that we shall constantly keep before our minds what those scientific truths demand of us in the treatment of each individual case. If we maintain such a mental attitude, we need not strive for, or indeed expect, absolute uniformity of practice. The more clearly we recognise the principles which are the common guides of all of us, the more we shall agree in that which is essential, and be free to differ as we please in carrying out the various details of our every-day procedures.

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